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DESCRIPTION

METHOD OF WATERPROOFING CONNECTED PORTION OF COVERED ELECTRIC WIRE

Technical Field

The present invention relates to a method of waterproofing a connected portion of a covered electric wire, especially a wire harness of a motor vehicle.

Related Art

Wire harnesses in a motor vehicle have a plurality of connected portions of covered electric wires. It is necessary to isolate and waterproof the connected portions from outside. Several conventional methods are suggested.

FIG. 4 shows a conventional connecting method disclosed in JP,S63-157163,U. A connected portion A4 has core wires of electric wires A2 and A3 of a wire harness A1. Insulating sheets A5 made of the same material as that of the electric wires A2, A3 cover the connected portion A4 and are sealed together with ultrasonic bond. Although the connected portion A4 is insulated, water may enter into the insulating sheets A5 through clearances between the electric wires and the insulating sheet, and clearances between the electric wires so that the waterproof of the connected portion A4 is not ensured. The utilization of an ultrasonic bonding apparatus increases manufacturing cost.

JP,H01-189881,A disclosed a conventional method of connecting covered electric wires. As shown in FIG. 5A, a pair of electric wires B6 are twisted at core wires to form a connected portion B7 and a spacer B8 is inserted between the electric wires B6. The connected portion B7 is inserted into a metal sleeve B10 in a heat shrinkable tube B9. The connected portion B7 of FIG. 5B is crimped with the metal sleeve B10. The heat shrinkable tube B9 is then heated to contact with surfaces of the electric wires B6. This conventional method needs the shrinkable tube, metal sleeve and spacer, and increases manufacturing cost due to many working steps. It is difficult to insert the connected portion B7 into the metal sleeve B10 due to a large friction therebetween.

JP,S63-157163,U and JP,H01-189881,A disclosed other conventional methods. However, when water enters into core wires, the water enters further into covers of the electric wires due to capillary phenomenon and causes electric leakage.

FIG. 6 shows a conventional method disclosed in JP,H09-55278. Core wires 21b exposed from covers 21a of electric wires 21 are electrically connected together to form a connected portion 25. The connected portion 25, core wires 21b and covers 21a near to the core wires 21b are immersed into a cyano adhesive agent to attain penetration of the adhesive agent between the core wires 21b and are sealed with an insulation member. However, the hardened cyano adhesive agent covering the core wires 21b is thin and is easily subjected to hydrolysis with water.

FIG. 7 shows a conventional method disclosed in JP,H11-178142,A. An outer face of a connected portion 81 formed from core wires of electric wires W is covered with a hot-melt adhesive 83. A heat shrinkable tube 82 receiving the connected portion 81 is covered with the hot-melt adhesive 83 at one end thereof and seals the connected portion 81 when the heat shrinkable tube 81 is heated. However, the hot-melt adhesive has a high viscosity so that it is difficult for the adhesive to enter between the core wires. Accordingly, the core wires are easily exposed to water and the waterproof thereof is reduced.

Disclosure of the Invention

It is an object of the present invention to provide a method of waterproofing an electrically connected portion of a covered electric wire with an easy, fast and low cost process.

According to a first aspect of the present invention, a method of waterproofing of a connected portion of a covered electric wire includes the steps of: pouring a curable seal material into a protection cap, which protects the connected portion of the covered electric wire; inserting the connected portion of the covered electric wire and a near covered portion thereof into the curable seal material; irradiating electromagnetic wave to the curable seal material, said electromagnetic wave having a wavelength for photo-curing the curable seal material; and photo-curing the curable seal

material, wherein said curable seal material is formed with a cyanoacrylate resin composition having photo-curing property with a viscosity of at most 200mPa·s at a temperature of 25°C prior to curing, and an elongation at break of at least 20% after curing.

Preferably, the cyanoacrylate resin composition contains (A) a 2-cyanoacrylate, (B) a photopolymerization resin component containing two of at least one selected from acryloyl group and metacryloyl group in a molecule thereof, and (C) a photoradical polymerization initiator.

Preferably, the protection cap is made of a material transparent to the electromagnetic wave and the curable seal material is irradiated with the electromagnetic wave from exterior of the protection cap.

Brief Description of the Drawings

FIG. 1 shows a connected portion of covered electric wires waterproofed with a method of the present invention;

FIG. 2 is a perspective view of an electric wire assembly;

FIG. 3 illustrates that the electric wire assembly is being inserted into a protection cap receiving an adhesive;

FIG. 4 shows a method of connecting electric wires disclosed in JP,S63-157163,U;

FIG. 5A shows a method of connecting covered electric wires disclosed in JP,H01-189881;

FIG. 5B shows a method of connecting covered electric wires

disclosed in JP,H01-189881;

FIG. 6 shows a method of connecting covered electric wires disclosed in JP,H09-55278; and

FIG. 7 shows a method of connecting covered electric wires disclosed in JP,H11-178142.

Best Mode for Carrying out the Invention

The present invention utilizes a cyanoacrylate resin composition having photo-curing property as a curable seal material. The photo-curing seal material provides a fast and low cost hardening. The cyanoacrylate resin composition hardens with three dimensional cross-linkage and becomes a waterproof wall (a first waterproof wall) against for hydrolysis.

A minute amount of water on surfaces of covered electric wires and a connected portion functions as an initiator to anionic polymerize the cyanoacrylate resin composition and form a hardening layer of an anionic polymerization resin as a second waterproof wall. The second waterproof wall prevents the minute amount of water from penetrating between core wires after the water passes through the first waterproof wall.

In the present invention, photo-curing resin compositions mean chemical reaction type resin compositions capable of being radical polymerized with light.

In the present invention, the cyanoacrylate resin composition having photo-curing property has an elongation at break of at least 20% after photo-curing. The elongation at

break is measured for a dumbbell-3 type test piece prepared in accord with JIS K6251, with a tensile testing machine at a temperature of 23°C, a relative humidity (RH) of 50% and at a tension speed of 10mm/min.

A cyanoacrylate resin composition generally is hard and brittle and has the elongation at break of less than 5%. The resin is easily cracked with thermal shock. The cyanoacrylate resin composition of the present invention has the elongation at break of at least 20% so as to prevent the cracks and provide a waterproof to the connected portion. The cyanoacrylate resin composition of the present invention satisfies the requirements of heat resistance, cold resistance, humidity resistance, thermal shock resistance, salt-water resistance and provides a reliable high waterproof.

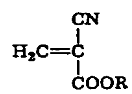
The cyanoacrylate resin composition, which has the elongation at break of at least 20% after curing, includes a photopolymerization resin component containing two of at least one selected from acryloyl group or metacryloyl group in a molecule thereof, in a usual cyanoacrylate resin composition.

The cyanoacrylate resin composition having photo-curing property contains (B) the photopolymerization resin component containing two of at least one selected from the acryloyl group or metacryloyl group in the molecule thereof besides (A) a 2-cyanoacrylate and (C) a photoradical polymerization initiator.

Each component is explained in detail. (A) A 2-

cyanoacrylate is a monomer having anionic polymerization and radical polymerization and forms a main component of the cyanoacrylate resin composition having photo-curing property. The 2-cyanoacrylate is a main component of cyanoacrylate instant adhesive. The preferable 2-cyanoacrylate has a chemical compound of Formula I.

Formula I



In Formula I, R denotes alkyl group, cycloalkyl group, haloalkyl group, alkoxyalkyl group, alkenyl group, cycloalkenyl group, alkynyl group or aryl group.

Preferably, the R of Formula I of the 2-cyanoacrylate is alkyl group, cycloalkyl group, haloalkyl group, alkoxyalkyl group, alkenyl group, cycloalkenyl group, alkynyl group or aryl group having a carbon number of 1-8. The preferable 2-cyanoacrylate having alkyl group is alkyl 2-cyanoacrylate, such as methyl 2-cyanoacrylate, ethyl 2-cyanoacrylate, n-propyl 2-cyanoacrylate, i-propyl 2-cyanoacrylate, n-butyl 2-cyanoacrylate, i-butyl 2-cyanoacrylate, n-octyl 2-cyanoacrylate. The preferable 2-cyanoacrylate having unsaturated group is alkenyl or alkynyl 2-cyanoacrylate such as allyl 2-cyanoacrylate and propargyl 2-cyanoacrylate; fluoroalkyl 2-cnanoacrylate such as 2,2,2-trifluoroethyl 2-cyanoacrylate, 2,2,3,3-tetrafluoropropyl 2-cyanoacrylate; alkoxyalkyl 2-cyanoacrylate such as methoxyethyl 2-

cyanoacrylate and ethoxyethyl 2-cyanoacrylate. It is not limited thereto. A single 2-cyanoacrylate is utilized or a plurality of the 2-cyanoacrylates are mixed to utilize.

Ethyl 2-cyanoacrylate, n-propyl 2-cyanoacrylate, i-propyl 2-cyanoacrylate, n-butyl 2-cyanoacrylate, i-butyl 2-cyanoacrylate, methoxyethyl 2-cyanoacrylate, and ethoxyethyl 2-cyanoacrylate are further preferable.

The photopolymerization resin component containing two of at least one selected from the acryloyl group and metacryloyl group in the molecule threof provides the elongation to the photo-curing cyanoacrylate resin composition. The example is given below.

Polyethyleneglycol dimethacrylate is provided by TOAGOSEI CO., LTD. with ARONIX M-260 and SHIN-NAKAMURA CHEMICAL CO., LTD. with NK ESTER A-600, 23G. Polypropyleneglycol dimethacrylate is provided by TOAGOSEI CO., LTD. with ARONIX M-270 and SHIN-NAKAMURA CHEMICAL CO., LTD. with NK ESTER APG-700, 23G. Urethane methacrylate is provided by TOAGOSEI CO., LTD. with ARONIX M-1310 and NIPPON GOHSEI CO., LTD. with UV3000B. Polyester methacrylate is provided by TOAGOSEI CO., LTD. with ARONIX M-6100 and NIPPON KAYAKU CO.,LTD. with KAYARAD HX-620. EO modified methacrylate of Bisphenol-A is provided by TOAGOSEI CO., LTD with ARONIX M-210. They are not limited to the companies. The photo-curing resin is utilized by one but may be mixed together. In the above, methacrylate includes acrylate.

Among the photo-curing resins, polyethelene glycol

dimethacrylate, polypropylene glycol dimethacrylate, urethane methacrylate and polyester methacrylate are preferable.

In order to have a resistance to the thermal shock, it is preferable that the resins have a glass transition temperature (Tg) below 0°C. The lower limit is not specified but is preferable above -50°C for the actual use of the adhesive.

The amount of the photo-curing resin component mixed with the 2-cyanoacrylate is preferable between 1wt% and 50wt% with respect to the total amount of the photo-curing resin component and 2-cyanoacrylate. A amount of 10-40wt% is more preferable. When the blending amount of the photo-curing resin component is less than 1wt%, the photo-cured material does not have a enough elongation. However, when the blending amount exceeding 50wt%, the viscosity of the resin composition increases so that the resin composition becomes hard to enter into the clearances of the core wires. The property of the instant adhesive is reduced.

The (C) photoradical polymerization initiator of the present invention initiates a radical polymerization of (A) 2-cyanoacrylate and (B) photopolymerization resin component containing two of at least one selected from the acryloyl group and metacryloyl group, with extraction of hydrogen or cleavage with light irradiation. One can use the known initiators.

(1) For extracting hydrogen, benzophenone series such as benzophenone, 2,4-dichlorobenzophenone, and o-benzoyl-methyl-benzoate, benzyl series such as benzyl and 4,4'-

dimethoxybenzyl, and ketone series such as camphoroquinone are utilized.

(2) For photocleavage, benzoin series such as benzoin, benzoin methyl ether, benzoin ethyl ether, acetophenone series such as acetophenone, 4-phenoxy-dichloroacetophenone, 4-t-butyl-dichloroacetophenone, α-hydroxyketone series such as 2-hydroxy-2-methyl-1-phenyl-propanone-1-on, 1-hydroxy-cyclohexyl-phenyl-ketone, acyl phosphine oxide series such as methylisobutyl-methylphosphonate, methylisobutyl-phenylphosphonate, 2,4,6-trimethyl benzoyl diphenyl phosphine oxide, bis(2,4,6-trimethyl benzoyl)-phenyl phosphine oxide, bis(2,6-dimethoxy benzoil)-2,4,4-trimethyl pentyl phosphine, are utilized but are mot limited thereto. One or the combination thereof can be utilized.

The α-hydroxyketone series and acyl phosphine oxide series are preferable for photoradical polymerization initiator. Preferably, the amount of the photoradical polymerization initiator is 0.01wt%-10wt%, more preferably 0.1wt%-5wt% with respect to the total amount of (A) the 2-cyanoacrylate and (B) photopolymerization resin component containing two of the metacryloyl group in the molecule.

Other components: The cyanoacrylate resin compositions may include stabilizers, polymerization accelerators, polymerization initiators, thickeners and additives.

Stabilizers: Anionic polymerization stabilizers such as sulfur dioxide, nitric oxide, hydrogen fluoride, sulfone

compound, BF_3 complex, methanesulfonic acid, and p-toluenesulfonic acid, and radical polymerization stabilizers such as hydroquinone, hydroquinone monomethyl ether, catechol, and pyrogallol are utilized for improving the stability of the curable seal material.

Polymerization accelerators: Crown ether, silacrown ether and calixarene are utilized for improving anionic polymerization and speed of adhesive of the curable seal material.

Polymerization Initiator: Organic peroxide such as di-t-butyl hydroperoxide and cumene hydroperoxide is added in order to improve a radical polymerization of the curable seal material.

Thickeners: The photo-curing cyanoacrylate resin composition of the present invention has a viscosity of at most 200mPa·s at a temperature of 25°C. Thickeners such as polymethylmethacrylate, methylmethacrylate/(metha) acrylic acid ester copolymer and cellulose derivative are utilized for adjusting the viscosity for the resin composition to enter into the electric wires.

Adhesion assisting agent, dye, spice, filler, cross-linking agent, and toughener are utilized when necessary. Conventional arts are utilized for these agents.

It is necessary that the photo-curing cyanoacrylate resin composition has a viscosity of at most 200mPa·s at a temperature of 25°C and preferably at most 100mPa·s. When the viscosity of

the curable seal material is more than 200mPa·s, the seal material does not penetrate between the core wires with capillary phenomenon and the anionic polymerization resin layer of the second waterproof wall becomes thinner or almost disappear so that it becomes difficult to achieve enough waterproof.

A method of waterproofing a connected portion of covered electric wires of the present invention is described below referring to drawings.

FIG. 1 shows a waterproofing portion 200 having a plurality of covered electric wires 71 and core wires 71b exposed from covered portion 71a. The core wires 71b are electrically connected together at a connected portion 75. The connected portion 75 and the covered portion 71a near to the connected portion 75 (near covered portion) are covered with a cylindrical protection cap 60 having a bottom. The protection cap 60 is made of a synthetic resin of insulation and is transparent to electromagnetic wave of 200-500nm. A curable seal material (a cyanoacrylate resin composition having photo-curing property) is filled between the protection cap 60 and the core wires 71b, and between the protection cap 60 and the near covered portion thereof (the covered portion 71a near to the connected portion 75). When the curable seal material is exposed to a light, the seal material radical polymerizes and forms a thick and strong layer.

Connection of electric wires:

The connection of the core wires 71b at the connected portion 75 of the waterproofing portion 200 is explained. The covered portion 71a of the plurality of the covered electric wires 71 are removed to expose the core wires 71b and the core wires 71b are aligned parallel to each other so as to have a flush end face. The aligned core wires 71b are welded or crimped to form an electric wire assembly 70 having the connected portion 75 as shown in FIG. 2.

Immersion of electric wire assembly to curable seal material and sealing between core wires and between electric wires:

As shown in FIG. 3, an end potion of the electric wire assembly 70 is inserted into a curable seal material 65, which is preliminarily poured into the protection cap 60, so as to immerse the connected portion 75, the core wires 71b and the near covered portion into the curable seal material 65. The near covered portion (the covered portion 71a near to the core wires 71b) is usually 3-20mm long. When the near covered portion of the connected portion is waterproofed with a short length, the covered electric wires 71 can not attain enough waterproof. When the near covered portion of the connected portion is waterproofed with a long length, it becomes difficult to handle the covered electric wires, for example wire harness, and it wastes the wire harness. The curable seal material 65 may form a thick layer since the anionic polymerization does not occur in a short time so that the end portion of the electric wire

assembly 70 can be easily inserted into the protection cap 60. The curable seal material 65 has the viscosity of at most 200mPa·s at the temperature of 25°C prior to hardening so that it penetrates quickly between the core wires 71b within a few seconds with capillary phenomenon when the end portion of the electric wire assembly 70 is inserted. The curable seal material 65 comes into contact with surfaces of the core wires 71b and reacts with water, which acts as an initiator, at the surfaces of the core wires 71b to form a waterproof seal material (sealing layer) with anionic polymerization. The curable seal material 65 penetrated between the covered electric wires 71 of the near covered portion of the connected portion, which is not exposed to light through the protection cap 60, comes into contact with surfaces of the covered electric wires 71 and reacts with water, which acts as the initiator, at the surfaces of the covered electric wires 71 to form the waterproof seal material (sealing layer) with anionic polymerization.

Photo-curing of the curable seal material and method of sealing:

An unhardened curable seal material 65 in the protection cap 60 is photo-cured by irradiating visible light and/or ultra-violet ray into the protection cap 60 to generate radical polymerization within a short time at the connected portion 75, core wires 71b, and near covered portion of the connected portion.

Radiation source and intensity thereof:

Radiation sources utilized for the present invention are low-pressure mercury lamp, high-pressure mercury lamp, xenon lamp, and metal halide lamp. Electromagnetic wave for photo-curing is usually ultra-violet ray or visible light of 200-500nm wavelength. The intensity of the light transmitting through the protection cap 60 depends on species and quantity of photopolymerization initiators contained in the curable seal material 65. The intensity of the light is usually higher than $100mJ/cm^2$, preferably $200mJ/cm^2$-$10,000mJ/cm^2$.

Protection cap:

The protection cap is made of an insulating material to transmit the electromagnetic wave of 200-500nm wavelength, such as soft polyvinyl chloride resin, polypropylene, polyethylene, silicone, acrylics, polycarbonate, polyester, polyamide, and polytetrafluoroethylene. The material is not limited thereto.

The protection cap 60 having the bottom portion may have any shapes as far as the connected portion 75 is protected from electrical, mechanical and chemical damages. For example, the shapes are cylindrical, cone and square. The protection cap may have any shapes of opening and recess as far as the connected portion is easily inserted.

It is not necessary to irradiate the electromagnetic wave to the protection cap. The electromagnetic wave can be supplied to the protection cap with an optical fiber, which is attached to the connected portion and immersed into the curable seal material. In this case, the protection cap can be formed with

a material which does not transmit the electromagnetic wave for photo-curing. The optical fiber is cut out at a suitable position after the curable seal material is hardened.

The present invention utilizes the cyanoacrylate resin composition having a low viscosity and an elongation as the curable seal material. The cyanoacrylate resin composition is poured into the protection cap and the connected portion of the covered wires is inserted into the protection cap. Then the electromagnetic wave is irradiated to the resin composition. The present invention provides a simple, fast and low cost waterproof of the connected portion of the covered electric wires.

EXAMPLES

The present invention is explained in detail referring to embodiments. Examples and comparative examples are evaluated with the following conditions.

Protection cap:

A protection cap is made of a soft polyvinyl chloride resin with a thickness of 1mm.

Electric wire assembly:

An electric wire assembly is formed with ten of covered electric wires and an end portion of the electric wire assembly includes core wires crimped together.

Cyanoacrylate resin composition having property of photo-curing:

Curable seal materials having compositions given in TABLES 1 and 2 are prepared and evaluated with respect to the following properties. Curable seal materials for comparison are shown in TABLE 3 and also evaluated.

Viscosity: Viscosity is measured with E-type viscometer at a temperature of 25°C.

Set time: Set time is a period of time to reach a prescribed bonding strength and is measured for a test piece of copper in accord with JIS K 6861.

Photo-curing property: Photo-curing property is evaluated by measuring accumulated light intensity for curing the cyanoacrylate resin compositions with a thickness of 2mm, with a conveyer type curing unit (metal halide lamp 1500W of EYEGRAPHICS CO.). The light intensity is measured with a photoreceiver UVD-C365 and an optical powermeter UIT-150, product of USHIO INC., having a central wavelength of 365nm.

Elongation at break: Elongation at break is measured with a tensile tester for dumbbell-shaped tensile test specimens of type 3 (2mm thick) in accord with JIS K6251 at a temperature of 23°C, a room humidity of 50% and a tension speed of 10mm/min.

Penetrating height of curable seal material: Each curable seal material of 1g is poured into the respective protection cap and the electric wire assembly is inserted into the protection cap. The protection cap is irradiated with a curing unit (high pressure mercury lamp of 600W of EYEGRAPHICS CO.) with an accumulated light power of 6,000mJ/cm^2. The penetration

height of the curable seal material of the covered portion 71a is measured by cutting and opening the protection cap 60 after photo-curing.

Thermal shock: Thermal shock test is carried out on the electric wires waterproofed similarly to the test of penetrating height and a number of cycles is measured until a crack occurs to the curable seal material at the cycle between 100°C for 60min and −40°C for 60min.

Abbreviated signs in TABLE 1 show the following compounds. Tg means glass transition temperatures of the compounds.

M-1310: polyol urethanediacrylate (Tg: −25°C), HX-620: polyesterdiacrylate (Tg: −8°C), M-225 (Tg: −8°C) and M-270 (Tg: −32°C): polypropylene glycoldiacrylate, M-260: polyethylene glycol diacrylate (Tg: −34°C), M-220: tripropylene glycol diacrylate (Tg: 90°C), DPHA: dipentaerythritol penta and hexaacrylate (Tg: >250°C).

Irg819: bis (2,4,6-trimethylpenzoil)-phenyl phosphine oxide, Irg1800: a mixture of 1-hydroxy-cyclohexyl-phenyl-ketone and bis (2,6-dimethoxypenzoil)-2,4,4-trimethylpentyl phosphine oxide with a ratio of 75:25 at wt%, DC1173: 2-hydroxy-2-methyl-1-phenyl-propane-1-on, Irg184: 1-hydroxy-cyclohexyl-phenyl-ketone, and PMMA: polymethylmethacrylate.

TABLE 1

		Example 1	Example 2	Example 3	Example 4	Example 5
component(wt%)						
(A) 2-cyanoacrylate		i-butyl (50)	i-butyl (70)	i-butyl (90)	i-butyl (70)	i-butyl (70)
(B) photo-polymerization resin		M-1310 (50)	M-1310 (30)	M-1310 (10)	HX-620 (30)	HX-620 (30)
(C) photoradical polymerization initiator		Irg819 (3)	Irg819 (3)	Irg819 (3)	Irg819 (3)	Irg819 (3)
thickener						PMMA (3)
evaluation						
viscosity	mPa·s	30	13	10	10	140
set time	sec	90	10	5	10	20
photo-curing property	mJ/cm^2	4,000	4,000	6,000	4,000	4,000
elongation at break	%	120	105	35	40	20
penetrating height	mm	15	30	30	30	5
thermal shock	cycles	>1,000	>1,000	600	600	300

TABLE 2

		Example 6	Example 7	Example 8	Example 9
component(wt%)					
(A) 2-cyanoacrylate		i-butyl (70)	i-butyl (70)	i-butyl (70)	ethoxy ethyl (70)
(B) photo-polymerization resin		M-225 (30)	M-260 (30)	M-270 (30)	HX-620 (30)
(C) photoradical polymerization initiator		Irg819 (3)	Irg1800 (3)	Irg819 (2)	Irg819 (2)
thickener				DC1173 (2)	Irg184 (2)
evaluation					
viscosity	mPa·s	6	10	8	18
set time	sec	10	20	10	5
photo-curing property	mJ/cm^2	4,000	4,000	6,000	6,000
elongation at break	%	28	80	78	58
penetrating height	mm	35	30	30	30
thermal shock	cycles	100	>1,000	>1,000	>1,000

TABLE 3

		Comp. Example 1	Comp. Example 2	Comp. Example 3	Comp. Example 4
component (wt%)					
(A) 2-cyanoacrylate		i-butyl (70)	i-butyl (70)	i-butyl (70)	ethyl (100)
(B) photo-polymerization resin		M-220 (30)	DPHA (30)	HX-620 (30)	
(C) photoradical polymerization initiator		Irg819 (3)	Irg819 (3)	Irg819 (3)	
thickener				PMMA (5)	
photoanionic polymerization initiator					ethyl ferrocene (5)
evaluation					
viscosity	mPa·s	5	10	550	2
set time	sec	10	10	30	3
photo-curing property	mJ/cm^2	4,000	2,000	-	2,000
elongation at break	%	5	0	-	3
penetrating height	mm	35	30	0	35
thermal shock	cycles	0	0	-	0

In TABLE 3, - denotes that the evaluation is not carried out and Comp. Example means Comparative Example.

As seen in TABLES 1-3, the cyanoacrylate resin compositions of the present invention have a viscosity of at most 200mPa·s, an elongation at break of at least 20%, and a set time of at most 180 seconds so that the cyanoacrylate resin compositions provide a good productivity. The cyanoacrylate resin compositions have a photo-curing property of at most 10,000mJ/cm^2, which is attained with an apparatus of reasonable low cost, a penetrating height of at least 5mm, which is enough height for waterproofing, and a thermal shock of at least 100 cycles, which is a measure of resistance to environment and of

resistance to shock for a long-term use.

The connected portions of the Examples of the present invention are adapted to a motor vehicle and tested under actual environments of the vehicle operated. It is found that the connected portions of the Examples of the present invention provide a enough waterproofing to the motor vehicle.

Industrial Applicability

The present invention provides a method of waterproofing of an electrically connected portion of covered electric wires of wire harnesses in a vehicle with an easy, fast and low cost process. Accordingly, core wires and the covered electric wires are prevented from water entering thereinto so that corrosion of the core wires and current leakage of the covered electric wires are prevented and the waterproof and resistance to salt water are improved.